

ORIGINAL RESEARCH

THE IMMEDIATE AND LONG-TERM EFFECTS OF KINESIOTAPE® ON BALANCE AND FUNCTIONAL PERFORMANCE

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ABSTRACT

Background: The application of Kinesio Tex® tape (KT) results, in theory, in the improvement of muscle contractibility by supporting weakened muscles. The effect of KT on muscle strength has been investigated by numerous researchers who have theorized that KT facilitates an immediate increase in muscle strength by generating a concentric pull on the fascia. The effect of KT on balance and functional performance has been controversial because of the inconsistencies of tension and direction of pull required during application of KT and whether its use on healthy individuals provides therapeutic benefits.

Hypotheses/Purpose: The purpose of the present study was to investigate the immediate and long-term effects of the prescribed application (for facilitation) of KT when applied to the dominant lower extremity of healthy individuals. The hypothesis was that balance and functional performance would improve with the prescribed application of KT versus the sham application.

Study Design: Pretest-posttest repeated measures control group design.

Methods: Seventeen healthy subjects (9 males; 8 females) ranging from 18-35 years of age (mean age 23.3 ± 0.72), volunteered to participate in this study. KT was applied to the gastrocnemius of the participant's dominant leg using a prescribed application to facilitate muscle performance for the experimental group versus a sham application for the control group. The Biodex Balance System and four hop tests were utilized to assess balance, proprioception, and functional performance beginning on the first day including pre- and immediately post-KT application measurements. Subsequent measurements were performed 24, 72, and 120 hours after tape application. Repeated measures ANOVA's were performed for each individual dependent variable.

Results: There were no significant differences for main and interaction effects between KT and sham groups for the balance and four hop tests.

Conclusion: The results of the present study did not indicate any significant differences in balance and functional performance when KT was applied to the gastrocnemius muscle of the lower extremity.

Level of evidence: Level 1- Randomized Clinical Trial

Keywords: Balance, functional performance, kinesiotaping

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INTRODUCTION

Balance is defined as the ability to keep the body's center of mass within the limits of an individual's base of support.¹ The ability to balance is necessary for a variety of functional activities of daily living including ambulation and functional mobility.¹ Balance impairments have also been proven to have a direct correlation to sport related injuries and declines in overall athletic performance.² Since adequate balance is instrumental in sport and function, deficits must be addressed by appropriate treatment modalities to prevent injury and maintain or improve balance. For several years, non-elastic tapes have been frequently used to treat and prevent ankle injuries in athletes and thus restore normal balance capabilities during athletic competition.³ These types of non-elastic tape are used to provide stability to the joint without compromising normal joint mechanics.⁴ They may deliver a strong adhesion force leading to restraint of a body segment but may also cause skin discomfort.⁵ However, white athletic tape loses its effectiveness to prevent inversion ankle sprains after 10 minutes of use.⁶ While athletic tape is primarily utilized for structural support, Kinesio Tex tape® (KT) was created to provide therapeutic benefits while allowing support and stability to muscles and joints without restricting the body's range of motion.³ The elastic, acrylic adhesive tape differs from regular white athletic tape because of the wave-like grain design on the adhesive surface of KT.⁷ The specialized grain and elasticity of the tape provides a tensile force to the skin and is purported to lift the fascia and soft tissue allowing mobility while providing therapeutic benefits.⁸ KT is air permeable and water resistant, allowing it to stay in place for three to five days secondary to its ability to resist moisture without affecting the adhesive quality of the tape.⁹ The comfort and freedom of motion after application are unique KT characteristics that athletes value.⁹ Numerous beneficial effects have been suggested depending upon KT application technique. The application of KT has been suggested to result in the improvement of muscle contractility by supporting weakened muscles; decrease inflammation and pain by increasing lymphatic and blood flow; increase joint range of motion by adjusting misalignment of muscle fibers, myofascia and joints.¹⁰⁻¹³ Improving circulation and increasing proprioception using KT

have also been suggested.⁸ To attempt to enhance or facilitate a muscle contraction, KT is applied from muscle origin to insertion with stronger tension i.e. 25-50% of its original length.¹³ On the other hand, to attempt to inhibit or lessen a muscle contraction KT is applied from the muscle insertion to origin with weaker tension i.e. 15-25% of its original length.¹³

The possible effect of KT on muscle strength has been investigated by numerous researchers that have theorized that KT facilitates an immediate increase in muscle strength by generating a concentric pull on the fascia.¹⁴ Vercelli et al¹⁵ analyzed the effect of KT on knee extension using three different application approaches including facilitation taping, inhibition taping, and sham taping. None of the three conditions showed an immediate increase or decrease in strength in subjects, when compared to a baseline measure obtained using an isokinetic dynamometer. Similar to Vercelli, Fu and his colleagues applied KT to the quadriceps of healthy athletes and assessed strength also using an isokinetic dynamometer.¹⁶ Strength was assessed immediately following application as well as after a 12-hour period. There were no significant differences immediately after the KT application and when tested 12-hours following application. The inconsistent application and tension applied to the tape may be responsible for the lack of significant findings in the previously presented research.^{15, 16}

Lins et al¹⁷ measured balance, using a computerized baropodometer, and also failed to note significant differences after the application of KT to the anterior thigh. However, they may have applied the KT to muscle groups that did not directly influence balance, as researchers have shown that sensory receptors in the muscles surrounding the ankle joint are the only source of information directly influencing postural sway and balance.¹⁸ Bicici et al⁴ studied the effect of KT on balance in basketball players with chronic ankle sprains. They concluded that KT did not improve or inhibit balance or functional performance in a population with a chronic musculoskeletal condition. Their results may have been due to less than optimal application of KT for the desired effect of facilitation, as the KT in their study was applied from distal to proximal, which would cause inhibition instead of facilitation according to Kase.¹³

Nakajima et al³ investigated the effects of KT on functional performance in healthy individuals. In their study, KT was also applied on the ankle musculature from insertion to origin; the technique suggested for muscle inhibition. Functional performance measured using vertical jump height and dynamic postural control was assessed at baseline (utilizing the Star Excursion Balance Test), immediately after KT application, and 24 hours after taping. Nakajima et al³ concluded that at 24 hours post application KT neither decreased nor increased vertical jump height in healthy non-injured young individuals, but did increase dynamic postural control in females, not the male subjects, however, only in two out of the eight directions tested. Limitations of this study include that the authors did not investigate effects of KT after a longer duration of application, and that they utilized a direction and tension of the taping application suggested for inhibition.

In addition to the discrepancies in the literature on the application and tension procedures, there are gaps in the literature regarding the effects of KT greater than 48 hours after application, as well as its effects on functional performance. As a result, the purpose of the present study is to investigate the immediate and long-term effects of the prescribed application of KT (for facilitation) when applied to the dominant lower extremity on healthy individuals. The hypothesis was that balance and functional performance would improve with the prescribed application of KT versus the sham application.

METHODS

Participants: Seventeen healthy subjects (9 males; 8 females) ranging from 18-35 years of age (mean age 23.3 ± 0.72), volunteered to participate in this study, a sample of convenience. All volunteers were healthy individuals who participated in moderate exercise at least twice per week. Exclusion criteria included: 1) individuals with any major musculoskeletal injuries over the previous six months, 2) health issues that would interfere with a subject's safety during exercise, 3) auditory/vestibular impairments, 4) uncorrected visual problems, 5) active malignancy, 6) active cellulitis or skin infection, 7) open wounds in area of application, and 8) history of deep vein thrombosis. All procedures of the investigation were conducted in accordance with the Helsinki Declara-

tion of 1975. The consent form and the study were approved by the Institutional Review Board of New York Institute of Technology.

Procedures: The participants signed the consent form prior to participation in the study. Participants were randomly assigned to either the control (sham KT without tension) or experimental group (KT with tension) in this double blind repeated measures study. There were four assessment periods for balance and functional ability, beginning with the first day pre- and immediately post- KT application. Measurements were also taken 24, 72, and 120 hours after the application of the KT (at the same time each day). The participant's dominant leg was determined by instructing them to kick a soccer ball; once the dominant leg was determined, it was then taped.²⁰ Each testing session began with the Biodex balance component followed by the functional performance tests (Four Hop Tests). Participants ceased all exercise during the four-day assessment period. The participants' physiological characteristics are presented in Table 1.

KT Application: KT was applied to the gastrocnemius of the participant's dominant leg, while in the prone position, after completion of all baseline assessments. The KT was cut into a Y-strip leaving two tails at one end in order to disperse tension through both heads of the gastrocnemius musculature. The first tail was anchored with no tension at the fibular head, and the other tail was anchored to the medial condyle of the tibia with no tension. After the anchors were secure, the participant's ankle was maximally dorsiflexed in order to stretch the gastrocnemius. The tape was then stretched to 50% tension as it coursed along the midline of the gastrocnemius to promote muscle activation as stated by Kase.¹³ The distal aspect of the tape was anchored to the Achilles tendon ending on the plantar surface of the calcaneus with no tension. The application was applied in the same manner, but with no tension for the control group. All partici-

Table 1. Subject Characteristics: Control (n = 9) Experimental (n = 8)		
Age (yrs)	24.63±5.85	22.00±1.58
Weight (kg)	70.48±16.45	60.44±7.68
Height (cm)	168.91±9.09	164.24±6.72
Reported as Mean±Standard Deviation		



Figure 1.

pants and the measurement team were blinded to their group assignment to increase the validity of the study and protect against the placebo effect. A Certified KT Practitioner completed each tape application in order to maintain consistency throughout the study. (Figure 1)

Balance Testing: Balance testing was conducted using the Balance System SD (Biodex Medical Systems, Shirley, NY). Each participant's age and height was entered into the unit so that normative values could be calculated. The participant then stood barefoot with their dominant foot centered on the balance platform for single-leg testing. The participant's sway while in single-leg stance caused the platform to move and the degrees of motion of the platform was recorded as the participant attempted to balance on the moveable surface. The participant received simultaneous visual feedback of the balance platform's position and its movement by a cur-

sor on a target where center was the optimal neutral position. Participants were instructed to keep the cursor in the middle of the target as they balanced without using their upper extremities for support. The average of two 20-second dynamic trials were performed and recorded for each leg. Balance ability was measured in units of Dynamic Stability Index (DSI) in which a lower index indicated less platform movement and, therefore, better balance. Reliability and validity of the Biodex Balance System has been previously documented by Schmitz et al.²¹

Hop Testing: Four hop tests comprised the functional performance testing. These included the single hop for distance, triple hop for distance, 6-meter timed hop, and cross-over hop for distance, in sequential order. Participants repeated all four hop tests three times each. The maximum distance or minimum time required to hop a measured distance during each of the three test trials were recorded. To perform the single hop test for distance, participants stood behind the starting line on the leg to be tested and landed on the same leg. The participants were instructed to hop as far as possible. The distance from the starting line to the back of the heel after completing the single hop was measured. The triple hop test was performed beginning by having the participant stand behind the starting line on the leg to be tested and hopping for three consecutive maximum hops on the same leg. The distance from the starting line to the back of the heel after completing the third hop was measured. The 6-m timed hop test consisted of the participant hopping 6-m as quickly as possible. Participants were instructed to perform one-legged hops, as quickly as possible from the starting line to the finish line. An electric stopwatch (Timex Ironman, Waterbury, CT, USA) was used to record the time elapsed. The crossover hop test was performed by the participant standing behind the starting line on the leg to be tested and hopping forward three times in succession while crossing a 15 cm-wide marked strip during each hop. The participant was instructed to hop as far as possible. The distance from the starting line to the heel after completing the third hop, was measured. The best score on each test was used for subsequent data analysis. The test trials were repeated if the participants were unable to complete it or lost their balance as demonstrated by contacting the ground with

the opposite foot. The reliability of this standardized hop-test protocol has been demonstrated in previous research by Reid et al.²³

STATISTICAL ANALYSIS

Statistical analyses were performed utilizing SPSS for Windows (version 22.0, Chicago, Ill.), using a multifactor repeated measures design. Repeated measures ANOVA's were performed for each individual dependent variable. The dependent variables were the four hop tests and the DSI score from the balance test, with time as the repeated factor. In the event of significant interaction and or main effects, appropriate post hoc analysis was used. The assumption of sphericity was tested using Mauchly's test, in the event that sphericity was violated a Greenhouse-Geisser correction factor was applied. A priori sample size calculations revealed that eight subjects were required in each group in order to detect observed differences at a power of 80%. Statistical significance was set at $p < 0.05$.

RESULTS

Descriptive characteristics of the subjects are presented in Table 1. The mean and standard deviation scores for each of the balance and each of the hop tests for both the KT and sham groups are presented in Table 2. There were no significant differences for main and interaction effects between KT and sham groups for the balance (DSI scores) and the hop tests. (Table 3)

DISCUSSION

The aim of the present study was to bridge the gap in knowledge and clarify discrepancies in the literature regarding the effects of KT on functional performance and balance, by providing 120 hours of wear time and the utilization of a prescribed KT application technique. However, the findings of the present study indicated that the application of KT when applied from origin to insertion of the gastrocnemius with 50% tension compared to sham application did not improve balance or functional performance. These results compare to those from a recent study by Nunes et al¹² who applied KT to healthy individuals in the same fashion as the present study and also failed to find any significant improvements in balance. They assessed balance during a single testing

Table 2. Scores of the Balance and Functional Performance Tests, reported as Mean \pm Standard Deviation

Crossover Hop (cm)	Control	Experimental
Pre	376.55 \pm 92.33	390.67 \pm 88.32
Post	387.63 \pm 115.85	409.17 \pm 95.89
24 Hour	397.79 \pm 100.46	403.77 \pm 85.68
72 Hour	403.38 \pm 93.31	408.20 \pm 86.50
120 Hour	353.85 \pm 175.95	347.14 \pm 149.45
Triple Hop (cm)	Control	Experimental
Pre	402.14 \pm 116.15	425.57 \pm 118.52
Post	427.80 \pm 124.01	425.41 \pm 105.20
24 Hour	446.94 \pm 105.68	438.56 \pm 99.77
72 Hour	446.55 \pm 109.48	440.28 \pm 97.13
120 Hour	363.43 \pm 182.96	371.77 \pm 161.29
6- Meter Hop (seconds)	Control	Experimental
Pre	2.23 \pm .51	2.08 \pm .46
Post	2.09 \pm .52	2.00 \pm .45
24 Hour	2.17 \pm .47	2.15 \pm .37
72 Hour	1.89 \pm .39	1.87 \pm .50
120 Hour	1.88 \pm .85	2.03 \pm .93
Single Hop (cm)	Control	Experimental
Pre	132.53 \pm 36.91	129.71 \pm 36.51
Post	133.05 \pm 38.20	136.12 \pm 29.64
24 Hour	133.91 \pm 35.51	138.56 \pm 27.68
72 Hour	138.81 \pm 34.02	135.83 \pm 28.71
120 Hour	109.29 \pm 56.94	111.42 \pm 47.72
DSI	Control	Experimental
Pre	1.79 \pm .37	1.55 \pm .54
Post	1.56 \pm .54	1.56 \pm .64
24 Hour	1.59 \pm .81	1.34 \pm .44
72 Hour	1.47 \pm .58	1.49 \pm .50
120 Hour	1.49 \pm .66	1.39 \pm .39

Pre = pre intervention, Post = immediately post intervention, 24 Hour= 24 hours after application, 72 Hour = 72 hours after application, 120 Hour = 120 hours after application, DSI = Dynamic Stability Index

Table 3. Results of 2X5 Repeated Measures ANOVA's for Balance and Functional Performance

	Group	Time	Interaction
Crossover	P=0.85	P=0.29	P=0.99
Triple Hop	P=0.95	P=0.13	P=0.82
6-Meter Hop	P=0.91	P=0.12	P=0.57
Single Hop	P=0.11	P=0.84	P=0.95
DSI	P=0.65	P=0.32	P=0.70

Group = Effect of Control vs. Experimental
Time = Effect of Time (Pre, Post, 24, 72 and 120 Hours Post)
Interaction = Interaction Effect between Group and Time
All results were not significant

session that took place anywhere from 48 hours to one week following application of KT. Failure to find statistically significant differences in performance or balance in the present study as well as Nunes' may be attributed to use of a healthy subject population. Since all participants were healthy active individuals who took part in activities that challenged their balance on a daily basis, their balance may not have been able to significantly improve. Lins et al¹⁷

assessed the effects of KT on balance and functional performance using taping to assist in activation of the anterior thigh musculature of healthy subjects. Although Lins used the prescribed KT application for muscle activation, they also failed to find a significant difference in outcome measures. The quadriceps and gastrocnemius-soleus complex have both been proven to play a significant role in jumping performance.¹¹ In addition, the gastrocnemius-soleus complex provides ankle stability during balance, which led the authors of the current study to tape the gastrocnemius-soleus complex. Although the same outcome measures and prescribed KT muscle activation technique as Lins et al were used in the current study, no significant improvements in any variables were demonstrated in healthy subjects.

Nakajima et al³ investigated the effects of KT on balance using a technique to treat lateral ankle sprains as depicted in Kenzo Kase's KT manual.¹³ In contrast to Bicici et al,⁴ Nakajima and colleagues used a variation of the inversion ankle sprain technique and subjects were all healthy individuals. Researchers applied three different strips of KT with 140% tension to gastrocnemius, anterior tibialis and peroneals from distal to proximal. The investigators found no significant improvements in vertical jump or dynamic posture both immediately and 24 hours following application of KT. Failure to find significant differences in the subjects in Nakajima's study might be related to application technique, tension of KT, as well as the subject population. Nakajima et al³ applied excessive tension, which neither inhibits nor activates but rather compresses the muscle; therefore, it is not desirable when aiming to improve balance. Nonetheless, due to variations in the current findings and previous findings, the authors of the current study acknowledge the need to evaluate effects of KT on subjects with musculoskeletal impairments.

The main limitation of the present study was the use of a healthy population because KT is typically prescribed for individuals with musculoskeletal injury or impairment. Another limitation may be that the KT was only applied to the gastrocnemius-soleus complex; thus, future studies could also apply KT to the quadriceps and peroneal musculature and study balance and performance.

CONCLUSION

The results of the present study did not show any significant difference in balance and functional performance when KT was applied to the gastrocnemius with or without tension in healthy individuals. Based on the results of this study, KT wearing time or application technique may not be reasons for lack of significant findings in balance or functional performance improvements, rather the reason may be that KT should be prescribed for patients with musculoskeletal impairments, as originally suggested by the creators of KT.

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